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Working Paper

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Kiel Working Papers, No. 200

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Kieler Arbeitspapiere
Kiel Working Papers

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The Elasticity of Substitution between Imported and Domestically Produced Goods in Germany*,+

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ISSN 0342 - 0787

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March 1984

* Kiel Working Papers are preliminary papers written by staff members of the Kiel Institute of World Economics. Responsibility for contents and distribution rests with the authors. Critical comments and suggestions for improvement are welcome. Quotations should be cleared with the authors.

+ This paper reports research undertaken in the "Sonderforschungsbereich 86" (Hamburg-Kiel) "Teilprojekt 3" with financial support provided by the "Deutsche Forschungsgemeinschaft".
Thanks are also due to Rolf Mirus, T. Tewes, and members of the section 4 workshop at the Kiel Institute of World Economics.

ISSN 0342 - 0787

The elasticity of substitution concept has become one of the mainstays in the measurement of price responsiveness not only in production theory, where it originates, but also in the study of international trade. It has been applied, for example, in the context of the world demand for exports from two competing sources (Richardson (1973), Zelder (1958)),to estimate one country's relative demand for imports from competing foreign sources (Hickman and Lau (1973), Morgan and Corlett (1951)), and to estimate one country's demand for imports relative to domestic substitutes (Alaouze (1977), Mutti (1977)). The present paper pursues the last issue by examining the elasticity of substitution between the demand for commodity imports and domestic substitutes in the Federal Republic of Germany, using data disaggregated at an industry level.

In one way or another, all these studies share a similar objective, which is to measure the sensitivity of a country's or industry's competitive position in world trade. In view of the disaggregation employed here, the elasticity measures are likely of more use in economic discussions focusing on the sectoral distribution of the impact of commercial policy measures or exchange rate changes, rather than such traditional macroeconomic issues as the response to a devaluation of a country's overall trade balance. For example, they may serve to aid policymakers in assessing which sectors in the economy would face relatively greater adjustment burdens in the event of changes in the terms of trade.

Another more direct motivation for seeking to obtain estimates of this particular elasticity concept is the fact that it plays an important part in several well-known simulation models such as Armington's (1969, 1970) (also used by Verdoorn and Schwartz (1972) to measure the effects of economic integration) and the more recent class of ORANI models described in Dixon et al (1981).[1]

It will be useful at this point to address two main criticisms which have in the past been levied against this elasticity concept, since these have influenced the course of the investigation pursued here. The first objection is that the elasticity of substitution concept forces the modeler to accept quite strong constraints on conventional demand functions. It may well be that the underlying demand structure is such that it does not easily lend itself to any representation involving a constant elasticity of substitution. This objection can be confronted by directly testing the validity of the constraints imposed on more general demand specifications, as was done, e.g., in Mutti (1977) and Richardson (1973). This testing procedure is also adopted here, only that attention is devoted entirely to the relative demand for imports and domestic substitutes rather than to absolute demands. The results from these tests do not lend strong support to fears that the mere CES constraint might be unduly restrictive.

The second objection is of a more fundamental nature and has been voiced frequently by proponents of what is commonly referred to as the "monetary approach". This literature questions the relevance of the "elasticities" approach based on imperfect substitutability between imports and domestic substitutes on the premise that national origin should not be a significant argument in preference functions. Perhaps the following brief discussion can provide some clarifications: With sufficient product disaggregation, as the imported good and the domestic equivalent become increasingly identical, one would conjecture that the elasticity of substitution between both goods has to approach infinity (unless one is prepared to question some even more fundamental precepts of demand theory). Moreover, this elasticity would become increasingly more difficult to identify, since commodity arbitrage would tend to equalize prices until in the limit the relative price is always one. If this does not occur, then it can only be due to the fact that the imported good in question has no direct domestically-produced counterpart or vice-versa. In attempting to estimate a substitution elasticity in this case, one would then be forced to provide a justification for juxtaposing precisely these two goods rather than some other arbitrary pair. What this argument forces us to recognize is that in estimating an elasticity of substitution we are making as much a statement about collective behavior as about the composition of the particular commodity bundles being compared. There is, in other words, little point to speaking of <u>the</u> elasticity of substitution without additional qualification.

One way to meet the "monetarist" criticism, is to test the "law of one price". This is done here by estimating the degree of goods price arbitrage in all the sectors for which elasticities were estimated, in a manner similar to the study by Richardson (1978). As will be seen later,the law of one price is rejected by these tests for most of the sectors involved. However, these estimates can also be put to additional use. One would conjecture that the higher is the price responsiveness in a particular sector, the greater would be the amount of price arbitrage in that sector. It may therefore be of interest to compare the relative degree of price arbitrage occurring in different sectors with the relative sizes of the substitution elasticities obtained for those sectors.

Finally, a few comments regarding the data employed and the estimation procedures: Previous researchers in this area have often become confronted with severe data limitations; a fact lamented and discussed, for example, in both Kravis and Lipsey (1974) and Richardson (1976). This problem is most acute in the case of export and import price indices, forcing economists to take recourse to unit values. Furthermore, the commodity classifications used to aggregate traded goods flows often do not correspond to the classification used for domestic production. Germany provides one of the very few exceptions to this rule in that compatible series are available for exports, imports, and domestic production along with the corresponding price indices, all based on the same classification scheme. This is the Warenverzeichnis für die Industriestatistik, which disaggregates the German goods-producing sector into roughly 50 industries.

In recent years, some related work has been done in this area which is based on dynamic theoretical foundations, focusing on short-run behavior. Examples of this approach are Alaouze (1976, 1977), Aspe and Giavazzi (1982) and Gregory (1971), with empirical applications generally based on monthly or quarterly data. Underlying those models is the principle that behavioral adjustments take time; in particular that they take longer than the unit interval for which data is collected. In contrast, the estimations in this paper are based on annual data, where price indices represent yearly averages. This appears preferable for the models used here, as they rely on a more traditional, static conceptualization. The implicit assumption is that all adjustments, as well as the clearing of markets, occur within a year.

The remainder of the paper is organized in the following manner: In section 1, the basic model is developed, including a discussion of the various constraints that lead to alternative equation specifications. In section 2, these equations are estimated and the various constraints tested. In section 3, a measure of the degree of commodity arbitrage is estimated for each industrial sector. The resulting estimates are then compared with the preceding elasticity estimates. In section 4, some general conclusions are drawn.

1. Alternative Specifications of the Model

The demands for imports and domestic substitutes are represented by the following log-linear approximation:

(1) $\ell nM = \alpha_O + \alpha_1 \ell nY + \alpha_2 \ell nP_M + \alpha_3 \ell nP_D + \alpha_4 \ell nP$

(2) $\ell nD = \beta_O + \beta_1 \ell nY + \beta_2 \ell nP_M + \beta_3 \ell nP_D + \beta_4 \ell nP$

The symbols M and D refer to the quantity of imports and of competing domestic production sold in Germany. Their respective prices are given by the variables P_M and P_D. Variable Y refers to nominal GNP and variable P represents the aggregate price of all other products sold in the domestic market. This specification already embodies several assailable restrictions such as log-linearity, the assumption that other goods can be treated as an aggregate, and that the exchange rate and the foreign goods price (jointly captured by P_M) have the same effects on demand. Yet it appears to have been the most widely used formulation in previous research, and will be employed here as a starting point.

The aim in many related traditional studies has been to seek estimates of the structural parameters in (1) or (2) (the α_i's and β_i's). Orcutt (1951) had cautioned against estimating (1) and (2) directly, using single equation methods, in view of the strong possibility of simultaneity bias. These fears appeared to be borne out in subsequent estimation attempts in that most results have been considered more or less disappointing. Several attempts have also been made to account for supply side effects using an instrumental variables approach (e.g. Richardson (1976)), however, these cannot yet be considered clear-cut improvements.

A different way of representing these demand relationships is in relative form, by subtracting (2) from (1). This yields

$$(3) \qquad \ln(M/D) = a_0 + a_1 \ln Y + a_2 \ln P_M + a_3 \ln P_D + a_4 \ln P$$

where $a_i \equiv \alpha_i - \beta_i$. The drawback in choosing this specification is that the original structural parameters cannot be identified from the estimates of the composite parameters, a_i. Insofar as the questions to be addressed require information on the original parameters, the advantages gained by this procedure would not be obvious. On the positive side, however, there are reasons to suppose that the relation expressed in (3) would be more stable than either of the individual demand relations, (1) and (2). As Leamer and Stern (1970) point out, this would have the effect that single-equation estimates of the a's would be less subject to downward bias, due to supply-side effects, than the corresponding estimates of the α's and β's.[2] This reduction in bias, if it in fact obtains, can then be exploited to test for the validity of various restrictions which have in the past been imposed on the demand system represented by equations (1) and (2).

Equations (1) and (2) have frequently been derived with reference to consumer theory as the motivating paradigm, even though, as in this paper, total demand including intermediate input demands are considered. From this viewpoint, the assumption that agents are not subject to money illusion leads to the homogeneity condition: $\alpha_1 + \alpha_2 + \alpha_3 + \alpha_4 = 0$ and $\beta_1 + \beta_2 + \beta_3 + \beta_4 = 0$. This would be jointly captured in equation (3) by the assumption that $a_1 + a_2 + a_3 + a_4 = 0$, which yields

$$(4) \quad \ell n(M/D) = a_0 + a_1 \ell n(Y/P) + a_2 \ell n(P_M/P) + a_3 \ell n(P_D/P).$$

This has also the advantage of reducing the potential multicollinearity problem present in equation (3).

A separate restriction which is often imposed on the system of equations (1) and (2) because of its technical usefulness in various contexts is the assumption of a constant elasticity of substitution (CES) between similar goods categories. This implies the joint condition that $\alpha_2 = -\alpha_3$ and $\beta_2 = -\beta_3$, or in terms of equation (3), the condition is that $a_2 = -a_3$. This leads to the specification

$$(5) \quad \ell n(M/D) = a_0 + a_1 \ell n Y + a_3 \ell n(P_D/P_M) + a_4 \ell n P.$$

where a_3 becomes the elasticity of substitution, anticipated to be positive.

When both the homogeneity condition and the CES assumption are applied simultaneously, equation (3) reduces to

$$(6) \quad \ell n(M/D) = a_0 + a_1 \ell n(Y/P) + a_3 \ell n(P_D/P_M).$$

Finally, we come to the most direct, and therefore most popular, way of estimating the elasticity of substitution. This involves the additional restriction, with reference to equation (6), that $a_1 = 0$ (or $\alpha_1 = \beta_1$), yielding,

$$(7) \quad \ln(M/D) = a_0 + a_3 \ln(P_D/P_M).$$

In the next section, equations (3), (4), (5), (6) and (7) are each estimated for 23 industries, followed by a series of F-tests on each successive parameter restriction.

2. The Elasticity Estimations

a) The Data

Equations (3)-(7) were each estimated using annual figures from 1960 through 1981 for 23 industrial sectors classified according to the Warenverzeichnis für die Industriestatistik (WI). These sectors are grouped by the Statistisches Bundesamt into primary goods, investment goods and consumption goods industries. Those industries which have not been included in the analysis were omitted simply on the basis that some data was not as conveniently available or because of breaks in the time series due to product reclassification - no other efforts were made to bias the sample.

The dependent variable, $\ln(M/D)$, was constructed for each sector i as: $\ln(\hat{M}_i/P_{Mi}) - \ln(\hat{Q}_i/P_{Di} - \hat{X}_i/P_{Xi})$, where $\hat{M}_i$ and $\hat{X}_i$ are the total import and export volumes respectively (available in Statistisches Bundesamt, Fachserie 7, Reihe 1), $\hat{Q}_i$ is the value of domestic production (Fachserie 18, Reihe 7), and P_{Mi} (c.i.f.), P_{Xi} (f.o.b.), P_{Di} are the corresponding indices of average price levels in D-Mark (Fachserie 17, Reihen 8 and 2). The Industrial Wholesale Price Index, published in the International Financial Statistics, was used for the independent variable P, which represents the composite price level of all other commodities. Some experimentation was also done using the Consumer Price Index. This led to a slight deterioration in fit, without leaving an appreciably different imprint on the other parameter estimates. Figures for nominal GNP were also taken from the International Financial Statistics to represent the independent income term, Y.

b) The Estimation Results

The estimates of equations (3)-(7) are reported in Tables 1 through 5. In all cases a Cochrane-Orcutt procedure (CORC) was employed. As can be seen from the Rho values in Table 1, which represent the estimated first-order autocorrelation coefficients of the residuals using the untransformed data, the serial correlation problems which warranted such a procedure were only present in about one-half of the cases examined. However, as more restrictions were imposed on the model, the problem of serial correlation became increasingly acute to the point where in the case of the most restrictive specification, reported in Table 5, all the Rho values became significant. The reason for applying the CORC transformation in all equations is because the constraint tests performed subsequently require a uniform estimation procedure across the different specifications. It may also be noted that the ordinary least squares estimation results, which are not presented here, were insignificantly different from the CORC estimates in those cases where serial correlation was not a serious problem. The Durbin-Watson values presented in the tables refer to the regression residuals after the variable transformations were made.

The F-statistic values in Table 6 were all constructed using the standard formula: $((SSR_R - SSR_U)/SSR_U)(T - k - 1)/n$; where SSR_R and SSR_U are the sums of squared residuals from the restricted and unrestricted estimations respectively. T is the number of observations, k is the number of independent variables in the unrestricted equation and n is the number of linear restrictions. The results from the individual tests were as follows:

1) In column 1 is tested the homogeneity assumption by comparing the residuals from equation (4) (Table 2) with the residuals from the unrestricted equation (3) (Table 1). The homogeneity assumption is rejected in 7 out of 23 cases at the 5 percent significance level. Surprising is the observation that most rejections occur in those industries which are grouped as consumption goods (4 of 8), even though household demand theory is often

used as the theoretical motivation behind this restriction. At the 1 percent significance level note that the only rejections occur in the consumption goods industries.[3]

2) In column 2, the CES assumption is tested by comparing the residuals from equation (5), Table 3, with the residuals from equation (3). This restriction is only rejected 4 out of 23 times at the 5 percent significance level, and only once at the 1 percent level. From this result one would have to conclude that the fears expressed earlier, that the CES restriction may be too severe, do not receive much support from the data.

3) In column 3, the residuals from equation (6), Table 4, are compared to the residuals from equation (4), Table 2. This represents a conditional test of the CES assumption given that the homogeneity assumption is accepted.

4) In column 4, the residuals from equation (6), Table 4, are compared to the residuals from the unrestricted equation (3), thereby testing the homogeneity assumption and the CES assumption simultaneously. Once again, this simultaneous restriction appears least acceptable for the consumption goods industries.

5) In column 5, the residuals from the most restrictive specification (7), Table 5, are compared to the unrestricted equation (3) residuals. This represents a simultaneous test of homogeneity, CES, and of identical income expansion paths for imports and domestic substitutes (i.e. $a_1 = 0$).

6) In column 6, the residuals from equation (7), Table 5, are compared to the residuals from equation (5), Table 3. This represents a conditional test of both homogeneity and $a_2 = 0$, given that the CES assumption is accepted. Since both here and in the preceding case, the hypothesis is rejected in over half of the cases examined, we should regard with considerable suspicion those elasticity estimates derived by way of the more restrictive specification, equation (7).

Overall, these constraint tests point toward equation (5) as the proper specification for estimating the elasticity of substitution. This is unfortunate from the viewpoint of an elasticity optimist, as can be seen by comparing the estimates from Tables 3 and 5. In the case where the most restrictions are imposed, the elasticity of substitution turned out significantly positive in about half of the sampled industries, with only three estimates appearing with the wrong sign. In contrast, the substitution elasticities involving the least restrictions, in Table 3, appear with the wrong sign in seven cases. However, a case can still be made in support of the values in Table 3 as representing better estimates in terms of ranking different industries according to their sensitivity to relative price changes, even though the absolute values may be suspect. This will be done in the following section.

Observe with respect to Tables 1-4 that the coefficient on the income term in these regressions generally happens to be positive and is significantly negative in only two cases. There appears to be no clear demand-theoretical explanation for why import demand should generally respond more to income variations than the demand for domestic substitutes. One possible explanation may be what is being captured by this coefficient is the increased openness of the German economy over time, to which the formation of the EEC, shortly before the sample period begins in 1960, may have contributed. However, in adopting this argument some caution is required. To the extent that increased openness is brought about through a process of specialization within each economy for reasons of comparative advantage, so that imports become cheaper while domestic goods become more expensive due to higher foreign demand, this effect should hopefully be captured in the relative price term, P_D/P_M. This argument must rest instead on the hypothesis that the progressive reduction of trade barriers as well as technological developments have encouraged an increased flow of differentiated products which had not been available previously.

Note that the dependent term in all of these regressions, $\ln(M/D)$, may also be written as: $\ln(M/X) - \ln(Q/X - 1)$, where Q and X represent real domestic production and real exports of a commodity. Increasing openness of the economy would be reflected in a decline of variable Q/X, while M/X stays the same, which means that $\ell n(M/D)$ would be rising over time. This trend would be captured by the positive trend component in income, Y. In order to examine this hypothesis, $\ell n(M/D)$ was regressed against relative prices $\ell n(P_D/P_M)$, and a trend term. The results, not presented here, show that the trend variable is significantly positive in 20 out of 23 cases, while the estimated substitution elasticities for the most part remain approximately the same as the values on Table 4.

3. The Evidence on Commodity Arbitrage

From the introductory discussion recall the "monetarist approach" argument questioning the preceding approach to elasticity estimation. This argument states that if the domestic and imported goods being compared are truly substitutes, one would expect enough commodity arbitrage to take place with a tendency to equalize domestic and foreign prices. The relation between domestic and foreign prices can be expressed as:

(8) $\quad P_D = \gamma_O P_M^{\gamma_1}$, or $\ell n P_D = \ell n \gamma_O + \gamma_1 \ell n P_M$.

With perfect commodity arbitrage, purchasing power parity would obtain, meaning that $\gamma_1 = 1$. In that case, the relevant independent variable in the preceding calculations of the substitution elasticity would be $\ell n P_D - \ell n P_M = \ell n \gamma_O$ = constant. This would negate the usefulness of the previous regression techniques. If on the other hand the opposite extreme were to be true, namely the complete absence of commodity arbitrage so that $\gamma_1 = 0$, this would raise doubts as to whether the two commodity groups are actually substitutes which can be meaningfully compared.

A straightforward way of assessing these criticisms is to estimate the value of γ_1. This has also been done by Richardson (1978) for the case of U.S. and Canadian prices. However, he advises against a direct time-series estimation of equation (8), which corresponds to an absolute form of the purchasing power parity hypothesis. The suggested alternative is to examine a relative version of the PPP hypothesis, which is implied by equation (8). This is done by applying difference operators to the relation expressed in (8) to obtain:[4]

$$(9) \quad \Delta \ell n P_D = \gamma_0' + \gamma_1 \Delta \ell n P_M$$

and

$$(10) \quad \Delta^2 \ell n P_D = \gamma_0'' + \gamma_1 \Delta^2 \ell n P_M,$$

where $\Delta X \equiv X_t - X_{t-1}$ and $\Delta^2 X \equiv X_t - 2X_{t-1} + X_{t-2}$.

Equation (9) expresses a relation between the rates of inflation of domestic commodity prices and import substitute prices, while equation (10) expresses the same relation in terms of rates of change of inflation rates. The advantage of estimating these equations instead of equation (8) is that the problem of serial correlation, due to the generally acknowledged presence of trends in time-series data on prices is eliminated.

The estimation results for equations (9) and (10) are presented in Table 7. In all cases the estimated value of γ_1 has the expected positive sign and is less than 1. In the case of equation (9), γ_1 is significantly positive (at the 5% level) in 21 out of 23 industries, while in the case of equation (10) it is significant in 16 out of 23 industries. It is interesting to note that the inability to reject the absence of commodity arbitrage occurs most often in the investment goods industries. In all other sectors the evidence points strongly toward the existence of some commodity arbitrage.

Alternatively, the law of one price, implied by the hypothesis that $\gamma_1 = 1$, is rejected with 95 percent confidence in 17 out of 23 industries in the case of equation (9) and in 18 industries in the case of equation (10). It does not appear, then, that the existence of perfect commodity arbitrage poses as serious a statistical problem in most of the industries involved as had been advanced by the earlier monetarist argument.

Basic considerations of demand and supply behavior would suggest that in markets for substitutes characterized by a high elasticity of substitution in demand one would expect to observe a greater degree of commodity arbitrage than in markets characterized by low elasticities. This carries the implication that the single equation regression techniques used in the previous section might have led to biases for not taking into account supply side behavior. (See Stern and Zupnick (1962) and Tryfos (1975) for an elaboration of this critique). This would be true even when the law-of-one-price hypothesis is ruled out. Consequently, the absolute values of the elasticity estimates obtained earlier must be regarded with caution. Particularly suspect, of course, would be the negatively estimated values in Table 3, obtained by using the least restrictive equation specification.

What remains to be seen, however, is whether or not these estimated elasticities would be useful, if not in an absolute sense, at least in a relative sense, to compare the degree of price responsiveness in one industry to another. With this application in mind, we could consider those cases where negative elasticity estimates were obtained as simply a reflection of very low true elasticities. As discussed in the beginning, such a comparison may be useful to policymakers for assessing which industries are subject to greater competitive pressures from abroad.[5]

One way of testing this idea is by examining whether the elasticity magnitudes estimated in Table 3 are positively correlated with the degree of commodity arbitrage as estimated by the γ_1-coefficients in Table 7. A counter-hypothesis would be that in industries where the highest degree of commodity arbitrage takes place, the danger of obtaining downwardly biased single-equation elasticity estimates is greatest, so that the hypothesized relation would be negative. Equations (11) and (12) describe the results from regressing a_3 from Table 3 against each of the two commodity arbitrage coefficients from Table 7, denoted $\gamma_1(a)$ and $\gamma_2(b)$ respectively, employing all 23 sectors. Equations (13) and (14) describe the same regression when those sectors for which negative elasticity estimates were obtained are omitted.

$$(11)\quad a_3 = \underset{(.451)}{-.363} + \underset{(.801)}{1.442}\,\gamma_1(a) \qquad R^2=.134 \qquad T = 23 \qquad F(1,21)= 3.24$$

$$(12)\quad a_3 = \underset{(.309)}{-.207} + \underset{(.664)}{1.317}\,\gamma_1(b) \qquad R^2=.158 \qquad T = 23 \qquad F(1,21)= 3.93$$

$$(13)\quad a_3 = \underset{(.309)}{.229} + \underset{(.531)}{1.107}\,\gamma_1(a) \qquad R^2=.237 \qquad T = 16 \qquad F(1,14)= 4.35$$

$$(14)\quad a_3 = \underset{(.252)}{.261} + \underset{(.472)^*}{1.180}\,\gamma_1(b) \qquad R^2=.309 \qquad T = 16 \qquad F(1,14)= 6,25^*$$

T is the number of observations. F(,) represents the F-statistic for the regression. Numbers in parentheses are standard errors, and * indicates significance at the 5 percent level.

Note that in all cases the estimated relation between the previously calculated elasticity values and the degree of commodity arbitrage is positive, and most significant when the industries with wrong-signed elasticities were deleted. The same regression was also done using the estimated substitution elasticities from Table 5, the most restrictive model. The results from those regressions are summarized by observing that in all cases the signs and approximate coefficient sizes were the same. However, the R^2 values were uniformly lower, ranging between .056 and .115. These results also lend support, in addition to the F-tests performed earlier, for using the less restrictive specification, equation (5), to estimate the substitution elasticities in order to compare the relative demand responsiveness in different industries. This, despite the fact that generally higher and more significant elasticity values were estimated using the more restrictive specification, equation (7).

4. Summary

The conclusions which emerge from the preceding analysis can be divided in two parts. One part concerns the method of estimating elasticities and the other concerns the estimation results themselves. Regarding the method of estimation:

1) The series of F-tests have revealed that none of the alternative model specifications is applicable to all industries. However, they also suggest that the assumption of a constant elasticity of substitution is a relatively weak restriction; at least as acceptable empirically as the commonly-imposed homogeneity restriction.

2) The commodity arbitrage estimates have shown that in most cases the assumption of perfect arbitrage can be rejected. This implies that the domestically produced commodity bundles and the corresponding imports as aggregated here are better regarded as imperfect substitutes even though they are classified under the same heading.[6]

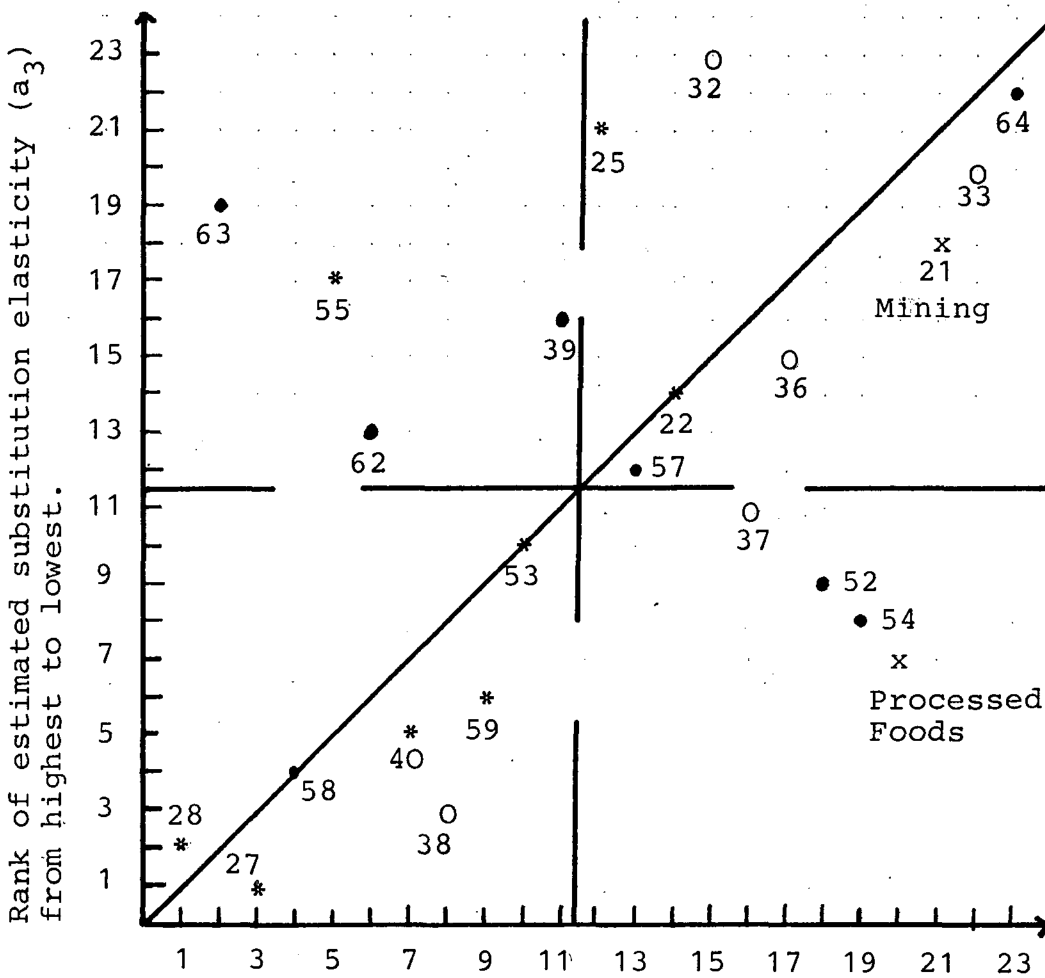
3) From the last series of regressions (11)-(14), it is shown that the magnitude of the elasticity of substitution characterizing product demands in particular industries is positively correlated with the degree of commodity arbitrage taking place in that industry. It was argued that this finding supports the validity of using the estimated elasticities in a comparative fashion to assess the relative degree of demand responsiveness to prices in different industries.

To address the estimates themselves, let us focus attention on Figure 1. All 23 industries are ranked according to the estimated size of the elasticity of substitution on the vertical axis. The elasticity values used in this ranking were taken from Table 3, the least restrictive model. On the horizontal axis, industries are ranked according to the estimated size of the commodity arbitrage coefficient $\gamma_1(b)$ on Table 7. The Spearman's Rank Correlation between both rankings is 0.44; significant at .05.

As a group, it appears that the primary goods industries are characterized by a relatively high degree of demand responsiveness to relative prices, with the exception of industries 55 (pulp and paper) and 25 (stone, clay, asbestos).[7] This is as anticipated since the primary goods sector consists of relatively homogeneous goods within each industrial category, easily duplicated abroad. Consequently one should expect this sector to be the one most subject to international competitive pressures.

In the investment goods sector, on the contrary, one would generally expect to find a great deal of product differentiation. For the case of capital goods, in particular, technological rigidities are likely to place limits on the substitutability between these goods, at least over the short-run. This is reflected in Figure 1 by the fact that the investment goods industries are scattered toward the northeast quadrant, displaying relatively low substitution elasticities, also with an exception provided by industry 38 (light metal products).

The consumption goods industries do not appear to be arranged in any easily identifiable pattern. On the basis of both rankings taken separately, they seem to be distributed fairly evenly over the entire spectrum, so that generalizing statements are not as readily forthcoming as in the previous two cases. A further difficulty is that the relation between measured elasticities and arbitrage coefficients appears least successful in this sector (seen by the off-diagonal outliers, industries 52, 54 and 63), so that great caution is advised in dealing with these results.[8] Nevertheless, these observations seem to point out that the consumption goods sector contains a more heterogeneous set of industries than either the primary or investment goods sectors. It includes, for example, industry 58 (plastics) whose products would be considered fairly standardized so that relative prices play a significant demand-determining role, and industry 64 (clothing) where tastes and fashion are relatively more influential.



Rank of estimated commodity arbitrage coefficient (γ_1) from highest to lowest.

Primary goods industries are denoted by *.
Investment goods industries are denoted by O.
Consumption goods industries are denoted by •.

Figure 1

Table 1 : $\ln(M/D) = a_0 + a_1 \ln Y + a_2 \ln P_M + a_3 \ln P_D + a_4 \ln P$

INDUSTRY	WI Nr.	a_1	a_2	a_3	a_4	R^2	D.W.	Rho
Processed foods, tobacco		.456 (.064) *	-.948 (.196) *	.494 (.487)	.211 (.324)	.972	1.85	-.08
Mining	21	1.381 (.302) *	.121 (.207)	-.113 (.526)	-1.153 (1.646)	.977	1.84	.49
Primary Goods Industries								
Mineral oil products	22	-.259 (.249)	.183 (.263)	-1.355 (.571) *	2.651 (1.066) *	.621	1.92	.12
Stone, clay, asbestos	25	.114 (.403)	.760 (.264) *	-.343 (.360)	-.349 (.428)	.888	2.00	-.04
Iron and steel	27	.758 (.158) *	-2.576 (.703) *	1.431 (.669) *	.381 (.486)	.955	1.99	.30
Non-ferrous metals	28	-.568 (.346)	-.690 (.436)	1.618 (.426) *	.164 (.699)	.915	1.63	.68
Chemical products	40	.398 (.538)	-.932 (.849)	.810 (1.907)	.374 (1.602)	.964	1.15	.80
Lumber and plywood	53	.289 (.334)	-1.282 (.475) *	2.925 (.753) *	-1.791 (.955)	.783	1.82	.53
Pulp and paper	55	.412 (.121) *	.037 (.259)	-.017 (.398)	-.147 (358)	.979	2.33	.55
Rubber products	59	-.364 (.380)	-.827 (.362) *	1.240 (.487)	1.037 (1.147)	.990	2.02	.82
Investment Goods Industries								
General machinery	32	.965 (.315) *	2.499 (.530) *	-1.604 (.997)	-.875 (.931)	.930	2.14	.04
Autos	33	1.702 (.209) *	.433 (1.066)	-.096 (1.317)	-1.682 (1.238)	.969	1.91	.14
Electro-technical products	36	1.164 (.135) *	-.047 (.407)	.143 (1.310)	-.067 (.852)	.993	1.88	.21
Fine mechanical, optical equipment, watches, etc.	37	.510 (.421)	-.501 (.662)	1.694 (1.021)	-.836 (.763)	.984	1.99	.65
Light metal products	38	1.319 (.227) *	-1.348 (.681)	-1.878 (1.409)	2.041 (.983) *	.987	1.75	.17
Consumer Goods Industries								
Musical instruments, toys, sports goods, etc.	39	.440 (.383)	-.867 (.922)	3.627 (2.232)	-2.154 (2.154)	.932	1.79	.15
Glass and glassware	52	1.052 (.383) *	-.009 (.731)	2.534 (1.323)	-2.642 (1.012) *	.974	1.84	.34
Wood products, furniture	54	1.082 (.445) *	-.612 (.365)	3.157 (1.320) *	-2.181 (1.057)	.974	1.47	.88
Printing and publishing products	57	.409 (.376)	-.675 (.715)	1.321 (1.219)	-.590 (.945)	.968	1.58	.67
Synthetic material products	58	2.147 (.518)	-1.162 (1.346)	.971 (1.582)	-2.024 (1.859)	.981	1.90	.32
Leather, leather goods, shoes	61+62	1.418 (.114) *	-.222 (.363)	.557 (.418)	-.406 (.393)	.994	2.01	-.05
Textiles	63	.548 (.057) *	.361 (.315)	-.047 (.371)	.727 (.256) *	.997	2.02	-.04
Clothing	64	1.891 (.233) *	.586 (.570)	-1.714 (1.472)	.511 (.936)	.997	1.88	.46

All estimates were made using a Cochrane-Orcutt procedure. * indicates significant t-values at 5% level. Numbers in parentheses are standard errors.

Table 2: $\ln(M/D) = a_0 + a_1 \ln(Y/P) + a_2 \ln(P_M/P) + a_3 \ln(P_D/P)$

INDUSTRY	WI Nr.	a_1	a_2	a_3	R^2	D.W.	Rho
Processed foods, tobacco		.527 (.044)*	-.985 (.203)*	-.033 (.334)	.968	1.85	-.04
Mining	21	1.433 (.223)*	.157 (.131)	-.004 (.353)	.977	1.81	.51
Primary Goods Industries							
Mineral oil products	22	.305 (.184)	.157 (.291)	-.561 (.610)	.511	1.92	.36
Stone, clay, asbestos	25	.217 (.034)*	.839 (.295)*	-.788 (.295)*	.865	1.99	.05
Iron and steel	27	.754 (.101)*	-2.575 (.681)*	1.433 (.631)*	.955	1.98	.30
Non-ferrous metals	28	-.245 (.454)	-.521 (.357)	1.448 (.338)*	.911	1.63	.83
Chemical products	40	-.578 (.570)	-.160 (.549)	-1.030 (1.334)	.966	1.28	.94
Lumber and plywood	53	1.622 (.628)*	-.881 (.397)*	1.785 (.710)*	.812	1.53	.89
Pulp and paper	55	.603 (.103)*	.328 (.235)	-.273 (.408)	.973	2.07	.59
Rubber products	59	-.817 (.483)	-.992 (.376)*	1.721 (.424)*	.988	1.68	.90
Investment Goods Industries							
General machinery	32	-1.079 (.721)	.279 (.737)	.651 (1.305)	.898	2.24	.90
Autos	33	1.799 (.177)*	-.329 (.627)	.062 (1.295)	.967	1.81	.14
Electro-technical products	36	1.176 (.139)*	-.485 (-322)	-1.958 (.565)*	.992	1.85	.19
Fine mechanical, optical equipment, watches, etc.	37	1.002 (.405)*	-1.031 (.629)	.322 (.914)	.980	1.73	.55
Light metal products	38	1.348 (.222)*	-1.673 (.542)*	-1.946 (1.391)	.987	1.74	.04
Consumer Goods Industries							
Musical instruments, toys, sports goods, etc.	39	.676 (.431)	-1.030 (.932)	5.370 (1.787)*	.928	1.71	.41
Glass and glassware	52	1.363 (.333)*	-.919 (.708)	.777 (1.078)	.969	1.52	.54
Wood products, furniture	54	1.801 (.544)*	-.634 (.515)	-.337 (1.454)	.945	.68	.86
Printing and publishing products	57	.438 (.396)	-1.260 (.585)*	2.079 (1.120)	.964	1.49	.70
Synthetic material products	58	2.149 (.502)*	-1.025 (1.021)	.915 (1.486)	.981	1.89	.34
Leather, leather goods, shoes	61+62	2.386 (.491)*	-.941 (.756)	.787 (.965)	.979	1.90	.77
Textiles	63	-.087 (.425)	-.552 (.806)	.397 (.939)	.986	1.32	.96
Clothing	64	2.558 (.077)*	.500 (.617)	-5.996 (.755)*	.995	1.68	.25

All estimates were made using a Cochrane-Orcutt procedure. * indicates significant t-values at 5% level. Numbers in parentheses are standard errors.

Table 3 : $\ln(M/D) = a_0 + a_1 \ln Y + a_3 \ln(P_D/P_M) + a_4 \ln P$

INDUSTRY	WI Nr.	a_1	a_3	a_4	R^2	D.W.	Rho
Processed foods, tobacco		.427 (.060)*	.932 (.200)*	-.082 (.132)	.970	1.73	-.02
Mining	21	1.379 (.274)*	-.120 (.174)	-1.134 (.639)*	.977	1.84	.49
Primary Goods Industries							
Mineral oil products	22	.317 (.288)	.233 (.243)	-.152 (.682)	.484	1.85	.47
Stone, clay, asbestos	25	.134 (.057)*	-.608 (.198)	.008 (.139)	.883	1.98	-.04
Iron and steel	27	.917 (.257)*	2.251 (.751)*	-.842 (.494)	.938	1.65	.56
Non-ferrous metals	28	-.565 (.557)	1.283 (.671)*	.944 (1.094)	.770	1.64	.68
Chemical products	40	.451 (.300)	1.009 (.473)*	.204 (.512)	.964	1.14	.79
Lumber and plywood	53	2.109 (.690)*	.788 (.415)*	-1.789 (.763)*	.788	1.39	.91
Pulp and paper	55	.407 (.100)*	-.047 (.232)	-.122 (.213)	.979	2.35	.55
Rubber products	59	-.554 (.284)*	.989 (.249)*	1.699 (.434)*	.990	2.03	.83
Investment Goods Industries							
General machinery	32	1.152 (.195)*	-2.283 (.444)	-.189 (.253)	.928	2.11	.04
Autos	33	1.726 (.185)*	-.332 (.910)	-1.413 (.448)*	.969	1.91	.13
Electro-technical products	36	1.166 (.130)*	.055 (.326)	-.015 (.213)	.993	1.88	.21
Fine mechanical, optical equipment, watches, etc.	37	.822 (.380)*	.662 (.612)	-.345 (.480)	.983	1.93	.56
Light metal products	38	.907 (.210)*	1.209 (.907)	-.514 (.280)*	.982	1.66	.27
Consumer Goods Industries							
Musical instruments, toys, sports goods, etc.	39	.695 (.308)*	.014 (.770)	1.234 (.706)*	.923	2.01	-.04
Glass and glassware	52	1.102 (.382)*	.812 (.682)	-.720 (.621)	.971	1.72	.60
Wood products, furniture	54	1.515 (.396)*	.831 (.369)*	-.448 (.503)	.969	1.31	.88
Printing and publishing products	57	.507 (.344)	.622 (.701)	-.012 (.463)	.967	1.67	.66
Synthetic material products	58	2.205 (.246)*	1.092 (1.219)	-2.254 (.487)*	.981	1.88	.32
Leather, leather goods, shoes	61+62	1.461 (.106)*	.334 (.345)	-.117 (.243)	.994	2.04	-.03
Textiles	63	.532 (.058)*	-.268 (.319)	.970 (.119)*	.997	1.95	.03
Clothing	64	1.719 (.158)*	-.697 (.559)	-.117 (.304)	.997	1.93	.54

All estimates were made using a Cochrane-Orcutt procedure. * indicates significant t-values at 5% level in a one-tailed test. Numbers in parentheses are standard errors.

Table 4 : $\ln(M/D) = a_0 + a_1 \ln(Y/P) + a_3 \ln(P_D/P_M)$

INDUSTRY	WI Nr.	a_1	a_3	R^2	D.W.	Rho
Processed foods, tobacco		.727 (.099)*	.874 (.274)*	.948	1.48	.56
Mining	21	1.538 (.127)*	-.206 (.103)	.977	1.88	.50
Primary Goods Industries						
Mineral oil products	22	.390 (.214)*	.173 (.166)	.480	1.87	.48
Stone, clay, asbestos	25	.217 (.033)*	-.813 (.169)	.865	1.99	.04
Iron and steel	27	.986 (.163)*	2.261 (.720)*	.938	1.66	.59
Non-ferrous metals	28	-.361 (.435)	1.053 (.521)*	.766	1.66	.69
Chemical products	40	-.148 (.416)	.792 (.369)*	.964	1.33	.95
Lumber and plywood	53	1.923 (.646)*	.782 (.411)*	.782	1.38	.89
Pulp and paper	55	.589 (.069)*	-.362 (.202)	.972	2.09	.57
Rubber products	59	-1.199 (.383)*	1.307 (.235)*	.988	1.77	.91
Investment Goods Industries						
General machinery	32	-.780 (.606)	-.143 (.709)	.895	2.30	.90
Autos	33	1.789 (.172)*	.320 (.610)	.967	1.80	.16
Electro-technical products	36	-.268 (.411)	1.460 (.446)*	.991	1.95	.94
Fine mechanical, optical equipment, watches, etc.	37	-.029 (.480)	.846 (.573)	.982	2.22	.92
Light metal products	38	.849 (.218)*	2.352 (.700)*	.979	1.64	.23
Consumer Goods Industries						
Musical instruments, toys, sports goods, etc.	39	2.016 (.485)*	-.201 (1.102)	.869	1.87	.57
Glass and glassware	52	1.379 (.317)*	.885 (.675)	.969	1.51	.53
Wood products, furniture	54	.500 (.492)	.947 (.450)*	.949	.92	.98
Printing and publishing products	57	.574 (.383)	1.199 (.578)*	.962	1.61	.73
Synthetic material products	58	2.186 (.220)*	1.003 (.966)	.981	1.88	.34
Leather, leather goods, shoes	61+62	.477 (.611)	1.057 (.541)*	.986	2.68	.95
Textiles	63	-.143 (.379)	.573 (.774)	.987	1.31	.96
Clothing	64	.304 (.527)	-.553 (.759)	.993	1.42	.95

All estimates were made using a Cochrane-Orcutt procedure. * indicates significant t-values at 5% level in a one-tailed test. Numbers in parentheses are standard errors.

Table 5 : $\ell n(M/D) = a_0 + a_3 \ell n(P_D/P_M)$

INDUSTRY	WI Nr.	a_3	R^2	D.W.	Rho
Processed foods, tobacco		.797 (.254)*	.937	2.07	.95
Mining	21	.053 (.107)	.973	2.09	.94
Primary Goods Industries					
Mineral oil products	22	.112 (.159)	.404	2.09	.68
Stone, clay, asbestos	25	-.765 (.322)	.777	2.51	.78
Iron and steel	27	2.841 (.725)*	.913	2.04	.93
Non-ferrous metals	28	1.218 (.489)*	.759	1.66	.75
Chemical products	40	1.065 (.279)*	.967	1.45	1.07
Lumber and plywood	53	.787 (.491)	.684	1.49	.76
Pulp and paper	55	.063 (.212)	.965	2.37	.90
Rubber products	59	1.404 (.285)*	.981	1.50	.90
Investment Goods Industries					
General machinery	32	-.469 (.632)	.884	2.27	.88
Autos	33	.818 (.941)	.953	2.53	.89
Electro-technical products	36	1.362 (.418)*	.991	1.89	.94
Fine mechanical, optical equipment, watches, etc.	37	.847 (.534)	.982	2.20	.91
Light metal products	38	4.911 (.360)*	.961	1.70	.35
Consumer Goods Industries					
Musical instruments, toys, sports goods, etc.	39	.555 (1.045)	.857	2.34	.91
Glass and glassware	52	.932 (.668)	.966	2.07	.91
Wood products, furniture	54	1.014 (.458)*	.942	1.04	.97
Printing and publishing products	57	2.191 (.218)*	.968	1.65	.51
Synthetic material products	58	1.007 (.976)	.976	2.01	.92
Leather, leather goods, shoes	61+62	.998 (.514)*	.986	2.78	.96
Textiles	63	1.361 (.607)*	.990	1.73	1.06
Clothing	64	-.465 (.730)	.992	1.44	.95

All estimates were made using a Cochrane-Orcutt procedure. *indicates significant t-values a 5% level in a one-tailed test. Numbers in parentheses are standard errors.

Table 6: Constraint Tests

INDUSTRY	WI Nr.	1 $(F_{1,16})$	2 $(F_{1,16})$	3 $(F_{1,17})$	4 $(F_{2,16})$	5 $(F_{3,16})$	6 $(F_{2,17})$
Processed foods, tobacco		2.026	-.953	10.707**	6.687**	6.358**	9.092**
Mining	21	.058	.002	.345	.192	1.100	1.753
Primary Goods Industries							
Mineral oil products	22	4.664*	5.820*	1.088	2.994	3.056	1.306
Stone, clay, asbestos	25	3.303	.778	.013	1.659	5.285**	7.642**
Iron and steel	27	0	6.247*	6.712*	3.157	5.042*	3.397
Non-ferrous metals	28	.740	27.210**	27.735**	14.025**	9.776**	.420
Chemical products	40	-.860	.011	.772	-.087	-.516	-.828
Lumber and plywood	53	-2.141	.423	2.715	.036	2.405	4.171*
Pulp and paper	55	4.846*	.010	.041	2.448	3.409*	5.427*
Rubber products	59	2.925	.254	.599	1.796	4.913*	7.579**
Investment Goods Industries							
General machinery	32	7.355*	.583	.618	4.101*	3.512*	5.103*
Autos	33	.792	.054	.041	.417	2.672	4.219*
Electro-technical products	36	3.020	.007	.797	1.956	1.385	2.204
Fine mechanical, optical equipment, watches, etc.	37	3.948	1.105	-2.259	.649	.449	.121
Light metal products	38	.655	6.480*	10.497**	5.468*	10.934**	9.961**
Consumer Goods Industries							
Musical instruments, toys, sports goods, etc.	39	1.104	2.261	13.895**	7.542**	5.954**	7.267**
Glass and glassware	52	2.810	1.523	.021	1.417	1.658	1.675
Wood products, furniture	54	18.026**	3.372	-1.126	7.886**	6.571**	7.176**
Printing and publishing products	57	2.198	.496	.745	1.498	1.678	2.339
Synthetic material products	58	.020	.016	.007	.014	1.336	1.786
Leather, leather goods, shoes	61+62	37.454**	.879	-5.174	10.592**	6.944**	10.055**
Textiles	63	50.754**	1.093	.300	24.688**	10.758**	15.515**
Clothing	64	8.244*	.473	10.827**	11.838**	8.136**	12.359**
Critical values of F statistic at:							
5 percent level of significance		4.49	4.49	4.45	3.63	3.24	3.59
1 percent level of significance		8.53	8.53	8.40	6.23	5.29	6.11

(* indicates rejection at 5% level of significance and ** indicates rejection at 1% level.)

Table 7

INDUSTRY	WI Nr.	(a) $\Delta \ln P_D = \gamma_0' + \gamma_1 \Delta \ln P_M$ γ_0	γ_1	R^2	D.W.	(b) $\Delta^2 \ln P_D = \gamma_0'' + \gamma_1 \Delta^2 \ln P_M$ γ_0	γ_1	R^2	D.W.
Processed foods, tobacco		.020 (.004)	.227 (.069)	.36	1.26	0 (.005)	.159 (.060)	.28	2.74
Mining	21	.043 (.013)	.251 (.060)	.48	1.75	.006 (.015)	.123 (.057)	.21	2.30
Primary Goods Industries									
Mineral oil products	22	.019 (.012)	.458 (.052)	.81	1.93	.005 (.016)	.373 (.052)	.74	3.00
Stone, clay, asbestos	25	.019 (.007)	.395 (.135)	.31	.80	0 (.005)	.435 (.138)	.35	1.54
Iron and steel	27	.007 (.006)	.809 (.100)	.77	2.08	0 (.009)	.862 (.111)	.77	3.04
Non-ferrous metals	28	-.014 (.013)	.935 (.094)	.83	2.02	.001 (.018)	.996 (.100)	.85	2.58
Chemical products	40	.012 (.003)	.600 (.036)	.93	1.54	0 (.004)	.556 (.034)	.94	2.32
Lumber and plywood	53	.012 (.009)	.505 (.098)	.58	1.66	-.001 (.011)	.493 (.090)	.63	2.58
Pulp and paper	55	.006 (.005)	.670 (.052)	.90	1.71	.003 (.007)	.727 (.061)	.89	2.10
Rubber products	59	.012 (.013)	.753 (.250)	.32	1.52	0 (.011)	.516 (.262)	.18	2.22
Investment Goods Industries									
General machinery	32	.036 (.007)	.363 (.171)	.19	.98	-.001 (.005)	.282 (.195)	.10	1.81
Autos	33	.022 (.006)	.431 (.166)	.26	1.06	.001 (.005)	.121 (.139)	.04	2.02
Electro-technical products	36	.019 (.005)	.269 (.147)	.15	1.12	0 (.005)	.207 (.165)	.08	2.07
Fine mechanical, optical equipment, watches, etc.	37	.032 (.004)	.301 (.124)	.24	1.19	-.002 (.005)	.255 (.130)	.18	2.11
Light metal products	38	.025 (.005)	.578 (.128)	.52	1.31	-.002 (.005)	.525 (.167)	.35	1.95
Consumer Goods Industries									
Musical instruments, toys, sports goods, etc.	39	.028 (.009)	.454 (.096)	.54	1.79	-.001 (.011)	.468 (.121)	.45	2.46
Glass and glassware	52	.030 (.006)	.324 (.145)	.21	2.06	0 (.008)	.196 (.198)	.05	2.72
Wood products, furniture	54	.031 (.007)	.165 (.107)	.11	1.11	0 (.005)	.168 (.102)	.13	2.14
Printing and publishing products	57	.032 (.005)	.534 (.109)	.56	1.99	0 (.006)	.383 (.139)	.30	2.22
Synthetical material products	58	.011 (.006)	.880 (.121)	.74	2.24	-.001 (.009)	.834 (.165)	.59	2.80
Leather, leather goods, shoes	61+62	.007 (.010)	.738 (.151)	.56	1.78	.001 (.011)	.593 (.127)	.55	2.71
Textiles	63	.004 (.004)	.879 (.100)	.80	1.65	-.001 (.005)	.900 (.110)	.79	2.42
Clothing	64	.021 (.005)	.345 (.121)	.30	1.32	0 (.003)	.089 (.098)	.04	1.68

All estimates were made using OLS. Numbers in parentheses are standard errors.

Appendix: $\ell n(M/D) = b_0 + b_1 \ell n(P_D/P_M) + b_2$ time

INDUSTRY	WI Nr.	b_1	b_2	R^2	D.W.
Processed foods, tobacco		.772 (.203)*	.032 (.001)*	.970	1.79
Mining	21	.259 (.089)*	.078 (.003)*	.980	1.30
Primary Goods Industries					
Mineral oil products	22	.236 (.205)	.019 (.012)	.461	1.85+
Stone, clay, asbestos	25	-.576 (.158)	.011 (.001)*	.886	2.09
Iron and steel	27	2.077 (.652)*	.041 (.003)*	.931	1.21
Non-ferrous metals	28	1.099 (.652)	-.007 (.025)	.760	1.65+
Chemical products	40	.992 (.357)*	.048 (.008)*	.972	1.21+
Lumber and plywood	53	2.463 (.492)*	.017 (.006)*	.581	1.39
Pulp and paper	55	.094 (.218)	.028 (.003)*	.973	2.23+
Rubber products	59	1.365 (.276)*	.048 (.009)*	.984	1.49+
Investment Goods Industries					
General machinery	32	-1.416 (.391)	.071 (.009)*	.913	1.35
Autos	33	.430 (.988)	.068 (.017)*	.958	2.21+
Electro-technical products	36	.596 (.193)*	.084 (.004)*	.995	1.73
Fine mechanical, optical equipment, watches, etc.	37	.833 (.417)	.049 (.012)*	.986	2.07+
Light metal products	38	2.262 (.634)*	.040 (.010)*	.978	1.15
Consumer Goods Industries					
Musical instruments, toys, sports goods, etc.	39	-.133 (.657)	.101 (.007)*	.927	1.87
Glass and glassware	52	1.094 (.652)	.052 (.015)*	.969	1.84+
Wood products, furniture	54	1.113 (.417)*	.081 (.014)*	.959	1.23+
Printing and publishing products	57	.483 (.586)	.044 (.015)*	.972	1.73+
Synthetic material products	58	.927 (1.028)	.051 (.033)	.977	1.91+
Leather, leather goods, shoes	61+62	.778 (.289)*	.113 (.002)*	.992	1.64
Textiles	63	1.023 (.643)	.090 (.010)*	.992	1.70+
Clothing	64	-.527 (.719)	.121 (.015)*	.994	1.54+

+ indicates Cochrane-Orcutt transformations were made. Otherwise OLS was used.

* indicates significant t-values at 10% level. Numbers in parentheses are standard errors.

Footnotes

1 The latter modeling technique is also being currently applied to the German economy by members of the Institut für Weltwirtschaft in Kiel. In reference to this, let me note that the data used in these estimations conforms basically to the same disaggregation scheme as the 58-sector input-output tables published by the German Statistisches Bundesamt, which form the backbone of the ORANI modeling structure.

2 See Leamer and Stern (1970), pg. 64.

3 Table 1 reveals that in many cases the price elasticity estimates emerge with opposite signs to the theoretically anticipated values, $a_2 < 0$ and $a_3 > 0$. An interesting regularity is that in 8 of the 9 industries where this was the case, the wrong signs came in pairs. A similar observation on the work by Morgan and Corlett (1951) led James Meade to conjecture that this may reflect a specification bias (multicollinearity?) when in fact demands depend on price ratios. From the elasticity estimates in Table 2, where the homogeneity restriction is imposed note however that wrong signs persist in 11 industries. Also in Table 4, when homogeneity and CES are imposed wrong signs persist in 6 industries. In other words, Meade's conjecture cannot be supported on the basis of this evidence.

4 Richardson (1978) tested the hypothesis that domestic prices react in precisely the same way to foreign price changes and exchange rate changes, using U.S.-Canadian data, and found that in most cases the hypothesis could not be rejected. This hypothesis is also maintained here given that P_M is already stated as the (c.i.f.) D-Mark price. Also, since Germany is relatively small compared to the rest of the world, it is appropriate to consider P_D as the dependent variable.

5 A common procedure in many applied simulation models is to conduct sensitivity tests whereby certain parameters, such as the elasticity of substitution, are expanded by a constant multiplicative factor. From this viewpoint, the usefulness of this study lies more in establishing the initial spread between the elasticities in different industries than in determining their absolute values.

6 See Richardson (1978), who arrives at a similar conclusion.

7 Regarding the two outliers provided by industries 25 and 55, note that different relative demand specifications do not alter their low elasticity rankings; seen by comparing Tables 4 and 5 with Table 3. In the case of industry 25 (stone, clay, asbestos), an argument could be made that these goods are similar in nature to those of the mining industry, also characterized by low elasticities, where the traditionally high level of protection and regulation afforded this sector in Germany contribute to the low observed demand responsiveness. It has also been conjectured that the existence of long term contracts (longer than one year) are a significant factor in these industries.

8 Focusing on the outliers belonging to the consumption sector, it turns out that by using the more restrictive specification for elasticity estimation for industries 62 (leather) and 63 (textiles), their estimated values rise significantly. At the same time, the estimated elasticity in industry 52 (glass) is reduced; see Tables 4 and 5. In these three cases, the revised elasticity rankings would conform more with the commodity arbitrage ranking, suggesting that for these industries the more restrictive estimation procedure might be more appropriate.

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